United States
Department of
Agriculture

Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins,
Colorado 80526

**Research Paper
RM-287**

Cost, Time, and Benefit Measures for Personal Use Fuelwood Collection in Colorado

David R. Betters, Donald C. Markstrom, and Robert Aukerman

USDA Forest Service
Research Paper RM-287

January 1990

Cost, Time, and Benefit Measures for Personal Use Fuelwood Collection in Colorado

David R. Betters, Professor
Colorado State University

Donald C. Markstrom, Research Forester
Rocky Mountain Forest and Range Experiment Station[1]

and

Robert Aukerman, Professor
Colorado State University

Abstract

The average fuelwood collector is willing to pay, beyond current perceived costs, an additional $21 to $29 per cord in order to continue collecting fuelwood. In general, current fuelwood permit prices are less than these additional willingness-to-pay (WTP) values. However, increasing permit fees must consider that commercial fuelwood markets also exist. Since many fuelwood collectors also buy fuelwood, this mixed market needs to be considered in developing pricing schemes. The difference between WTP estimates for fuelwood collection and for wood purchased from a commercial vendor is assumed to represent the recreational value of fuelwood collection. On this basis, the recreation value for the average collector is estimated to be between $6 and $12 per cord. These economic values may be compared with other empirical values placed on various types of outdoor recreation activities. The values may be used to help develop economically efficient allocations as part of the forest planning process.

[1]*Headquarters is in Fort Collins, in cooperation with Colorado State University.*

Cost, Time, and Benefit Measures for Personal Use Fuelwood Collection in Colorado

David R. Betters, Donald C. Markstrom, and Robert Aukerman

Management Implications

Fuelwood has become one of the major uses of wood in Colorado. A significant proportion of the fuelwood consumed is gathered by individual collectors. It is important to understand the economic relationships involved in the fuelwood collection process in order to compare this activity with other types of forest uses. Cost and benefit information for personal use fuelwood collection may be incorporated into the forest planning process to help develop economically efficient allocations of forest resources.

Introduction

The gathering of fuelwood by individual collectors has increased five-fold over the last 20 years (Gregory 1987). This increase has generated new competition for forest resources and stimulated interest in determining economic values related to the fuelwood collection process. Economic values are needed in order to measure net social benefits of fuelwood collection activities and to consequently make economically efficient allocations of forest resources between fuelwood collection and other forest activities.

Determining economic values for individually collected fuelwood is complicated by the numerous factors affecting the good itself and the collection experience. Theoretically, the value is based on some mix of the value of the activity and value of the resource. In this study, the difference between total willingness to pay (WTP) to collect and total WTP to purchase is used to measure the value of the recreational experience associated with personal use collection (Markstrom and Donnelly 1988). Several different contingent valuation approaches to estimate additional WTP are used as well as two separate data bases to help generate more accurate inferences.

Methods

Two independent surveys of fuelwood collectors were used as a source of data. One was completed in 1984 (hereafter called the "1984 study") and the other in 1986 (hereafter called the "1986 study"). The 1984 study used a "time-diary" approach to gather information from the USDA Forest Service fuelwood-cutting permit holders collecting wood from five Colorado national forests. The time-diary questionnaire was completed by collectors as they were actually involved in collecting fuelwood. This allowed for more accurate recording of time and costs. A total of 137 useable questionnaires were returned by the collectors after they completed collecting fuelwood.

In the 1986 study, 2,500 questionnaires were mailed to households picked from a random sample of listings from current telephone directories. In this study, 608 useable questionnaires were returned. Of this total, 337 were completed by individuals collecting all or part of their fuelwood needs. The 1986 sample included collectors using public as well as private lands.

Questions and format for the two surveys differed, yet certain data collected were similar and could be used to provide comparative economic values including comparisons between gathering and buying fuelwood.[2]

The data were converted to data base formats and verified using the personal computer package REFLEX (Borland Analytical Inc., Scotts Valley, CA). The program ABSTAT (Release 3.02, Anderson-Bell Company) was used to perform the statistical analysis. Distributions and descriptive statistics were developed for each study's questions pertinent to this analysis. Mean values were calculated for time, distance, and cost responses as well as for the collector's responses to contingent value questions.

WTP regression equations were derived for the 1984 (collecting) and 1986 (buying) data sets independently. The regressions were used to derive estimates of prices per cord and average and total WTP for both collectors and buyers. Using the WTP regressions, recreation values for the average collector were estimated by (1) the differences between price per cord for collecting vs. buying and (2) the differences between the average total WTP per cord of collectors vs. buyers. The estimates were made for the average fuelwood collector who consumes 1.6 cords per heating season.

Results

Collectors' Characteristics

The income distribution of the collectors was similar to the income distribution for the state's population as a whole, indicating no skewing to any particular income

[2]*The income distribution for the 1986 collectors (337) was compared to that of the 1984 sample (137). A statistical test (chi-square) indicated a statistically significant difference ($p = 0.005$, $\chi^2 = 54.9$) between the two distributions. The 1986 sample had somewhat higher representation in the lower income categories and lower representation in the middle income categories than the 1984 sample. Thus, the two data sets may not represent similar populations from the income perspective. Since there were no other population descriptors common to both surveys, no further testing could be made to determine if differences existed. Because the inflation rate over the 1984–86 period was relatively low, no inflationary adjustment was made to the cost and contingent value responses.*

group. Most collectors used natural gas (60%) or electricity (17%) as their primary heat source. Propane and fuel oil were also used, but by a much smaller segment of the sample. Both data sets indicated that a certain portion of the fuelwood gatherers also commercially purchased part of their fuelwood (20% of the 1984 sample and 50% of the 1986). In most cases, the amount bought, however, was considerably smaller than that gathered. Thus, the consumers appear to prefer gathering their own fuelwood. The fact that some are also buying fuelwood suggests that the commercial markets will influence the value placed on fuelwood gathering by personal use collectors.

Time and Costs

The 1984 study concentrated on more accurately defining the actual times and costs involved in the fuelwood collection process. In this case, the value being measured is based on the actual behavior of the consumer. Table 1 summarizes the average times and costs for various parts of the collection process.

It is clear that a substantial amount of time and effort goes into collecting a cord of wood. Even if the splitting and stacking of wood were done after the collecting, the average amount of time spent on the day of collection would still amount to 10.6 hours. It is understandable why the collectors consistently indicate "time and effort" (70% of the sample) and "travel time and distance" (30%) to be major factors influencing fuelwood use.

At the time of the 1984 survey, the average price of delivered commercial fuelwood was about $80 to $85 per cord. If the collection is perceived as a recreational activity and the direct costs of travel and permit fee were the only perceived cost, then the collector would have expenditures amounting to $40.09 per cord. Under these conditions, the consumer could recognize a savings in gathering fuelwood as opposed to buying.

Contingent Valuation

Several different variations of direct contingent value questions were asked in the two surveys to derive consumer benefit values. The questions were asked in such a way as to determine how much more collectors would be willing to spend in terms of time or money in order to continue, rather than forego, collecting fuelwood.

In this study these responses were used to derive values termed "additional WTP." Table 2 shows the responses and additional WTP estimates in terms of dollars and time. Although variations in contingent value questions can sometimes show large differences in values, the figures here are remarkably similar. The additional WTP for collecting based on travel mileage and the direct response in terms of dollars vary by a small amount. The estimates are similar to the total WTP in addition to travel and time cost derived by Markstrom and Rosenthal (1987) using a travel cost approach. This amounted to $21.42 per cord for fuelwood collection.

The figures in table 2 seem to be reasonable estimates of additional total WTP per cord. For example, if one uses the expenses per cord ($40.09) (table 1) and these additional WTP values (e.g., $27.11), the sum of the two is approximately $67 per cord. This figure is nearly the same as the collector's WTP regression equation price corresponding to the average collector's consumption level of 1.6 cords ($66.23) (table 3, column 2). Thus, the responses seem to be consistent in terms estimating the marginal benefits for the average collector.

Regression equations for individual consumer WTP (demand) schedules were developed from contingent value questions asking, "How many cords would you purchase (collect) at the following prices (total costs)?" The price/cost selections ranged from $25 per cord to $150 per cord. The 1984 survey asked the question in terms of collecting fuelwood, the 1986 survey in terms of buying. Table 3 shows the regressions and WTP estimates calculated from the survey results. Figure 1 graphically depicts the WTP values for the individual collector regression curve.

In general, there appears to be a greater total WTP for collecting fuelwood than for buying. Considering that either source yields fuelwood equally acceptable for providing heat, the differences in WTP must be related to the collection experience and its perceived cost savings.

The regressions may be used to estimate recreation values. In this study, two approaches are used to derive recreation value per cord collected by the average collector. First, the recreation value is estimated as the difference in price between collecting and buying at an

Table 1.—Average times and costs per cord for personal use collection.

Category	Average time (hr) per cord	Average cost ($) per cord
Collecting and loading wood at site	7.3	—
Splitting, stacking wood	6.9	—
Traveling to and from site	3.3	31.00[1]
Permit fee	N/A	9.09
Total	17.5	40.09

[1]*3.3 hr × $3.00/hr + $0.17 × 130 miles (average travel distance). The $0.17/mile figure was derived from gas and oil expenditure figures given by the respondents. Maintenance and repair cost were not included. The $3.00 figure is based on the U.S. Water Resources Council's (1983) recommendation to use one-third of the median wage rate ($9.00, U.S. Dept. of Labor 1989, Markstrom and Donnelly 1988).*

Table 2.—Contingent valuation and additional willingness to pay for the average collector (N/A = not available).

Question	Average response to the survey question		Additional total WTP per cord[1]	
	1984 survey	1986 survey	1984 survey	1986 survey
At what price per cord would you stop *buying* fuelwood?	$77	$109	—	—
How much more per cord would you pay in order to continue *collecting* fuelwood?	—	—	$27.11	N/A
At what round-trip distance would you stop *collecting* fuelwood?	213 miles	N/A	$29.05[2]	N/A
How much more time would you be willing to spend traveling? (*collecting*)	2 hr	1.5 hr	$28.00[3]	$21.00[3]

[1]*Using these values as estimates of additional willingness to pay assumes the average collector is collecting, and will continue collecting, 1.6 cords until this additional expenditure is reached, then collect nothing.*

[2]*The average distance travelled was 130 miles; thus, collectors were willing to travel an additional 83 miles (213 – 130) rather than forego collecting fuelwood. At a cost of $0.35/mile (gas, oil, and collector time), this amounts to $29.05 in terms of dollars ($0.35 × 83 miles). An average of one cord is collected per trip.*

[3]*Considering an average of 40 miles per hour and a cost of $0.35/mile, this amounts to $28.00 (80 miles × $0.35/mile) and $21.00 (60 miles × $0.35/mile), respectively. An average of one cord is collected per trip.*

Table 3.—Individual collector willingness-to-pay regression equations and associated values.

	Regression equation[1]	Total WTP[2]	Price (P) for 1.6 cords	Total WTP for 1.6 cords[3]	Average total WTP per cord[4]
1984 collector survey	$Y = -0.692 + 151.8/P$ $R^2 = 0.99$ $S_e = 0.23$ $0 \leq Y \leq 5.06$ cords	$312.00	$66.23	$172.09	$107.56
1986 buyer survey	$Y = -0.921 + 152.3/P$ $R^2 = 0.99$ $S_e = 0.21$ $0 \leq Y \leq 2.04$ cords	$177.23	$60.41	$152.66	$95.41

[1]*Where Y = cords collected (1984) or bought (1986) and P = total cost/price (including permit fees in case of 1984 survey). The R^2's in this case are high as mean values for numbers of cords taken for each price were used as the dependent variable.*

[2]*Total WTP is the area beneath the regression or the integral from P = 0 to P = 150 for each regression.*

[3]*The surveys show gatherers collect an average of 1.6 cords each heating season. A Public Service Company of Colorado survey in 1987 derived a similar figure. Using this figure in the regressions over a price interval of P = 0 to P = 150 gives the total WTP estimate.*

[4]*This is total WTP for 1.6 cords divided by 1.6.*

average consumption level of 1.6 cords (column 2) (table 3; $66.23 – $60.41) or approximately $6 per cord. Another estimate assumes that the recreation value for the average collector is the difference in average WTP per cord for collecting vs. buying (column 4) (table 3; $107.56 – $95.41) or approximately $12 per cord.

Thus, the approaches used here indicate a recreation value of $6 to $12 per cord. Considering one cord is collected per day, these figures are similar to empirical recreation day values derived in other studies. These studies show a range of $6 to $22 per recreation day for various types of outdoor recreation activities (Walsh 1986, p. 129).

As would be expected, the fewer cords collected or time spent collecting, the greater the marginal WTP per cord. Since the average number of cords used seasonally

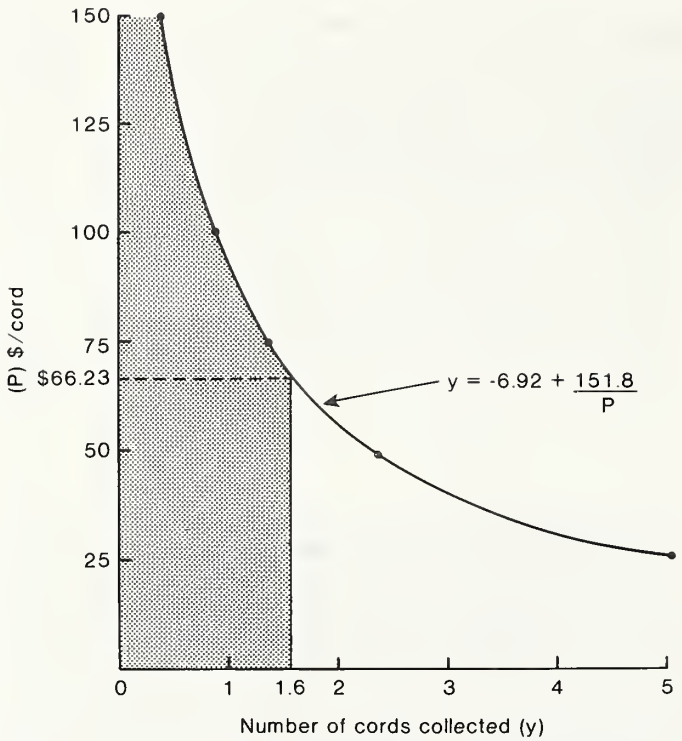

Figure 1.—Individual collector willingness to pay curve. Shaded area is *total* willingness to pay for a consumption level of 1.6 cords (column 3, table 3). A similar figure could be derived for the buyer survey regression.

per household, whether purchased or collected, is decreasing state-wide (Olsen and Betters 1989), the marginal WTP might be expected to increase in the future.

The regressions were also tested to determine if income influenced the WTP response. In this case, less than 10% of the variation in WTP was explained by the income variable. Other factors may prove significant in determining WTP. Some of these other exogenous factors might include type of wood burners used,[3] availability of nearby recreational facilities, prices of local commercial fuelwood, availability of collection sites, characteristics of the collection site, and conventional fuel prices. In addition, a large portion (25%) of the 1986 survey indicated "pleasure of collecting" as a key reason for collecting fuelwood; thus, factors such as sightseeing, exercise, companionship, etc., are important. Unfortunately, the data necessary to test the significance of these factors in detail was not available through these surveys but should be considered in future research.

[3]*For example, in the 1986 study, there was a clear difference between wood stove vs. fireplace users in terms of the maximum price they would pay for a cord, $87 vs. $99, respectively.*

Conclusions

There appears to be a significant recreational value associated with the fuelwood collection experience. The recreational value averages between $6 and $12 per cord. The additional WTP, or the amount that the collector would pay in order to continue collecting, averages between $21 and $29 per cord. The total WTP for commercial fuelwood is generally less than that for fuelwood collection. More research is necessary to determine how specific exogenous factors influence these average values.

Literature Cited

Gregory, G. 1987. Resource economics for foresters. New York, NY: John Wiley and Sons. 477 p.

Markstrom, D. C.; Donnelly, D. M. 1988. Christmas tree cutting and value as determined by the travel cost method. Western Journal of Applied Forestry. 3(3): 83–86.

Markstrom, D. C.; Rosenthal, D. H. 1987. Demand and value of firewood permits as determined by the travel cost method. Western Journal of Applied Forestry. 2(2): 48–50.

Olsen, W. K.; Betters, D. R. 1989. Domestic fuelwood consumption and supply in Colorado: characteristics, trends and projections. Tech. Bull. 89–1. Fort Collins, CO: Colorado Agricultural Experiment Station, Colorado State University. 24 p.

U.S. Department of Labor. 1989. Bureau of Labor Statistics. Supplement to employment and earnings. Washington, DC: U.S. Government Printing Office. 298 p.

U.S. Water Resources Council. 1983. Economic environmental principles for water and related land resources implementation studies. Washington, DC: U.S. Government Printing Office. 137 p.

Walsh, R. G. 1986. Recreation economic decisions: comparing benefits and costs. State College, PA: Venture Publishing, Inc. 637 p.

Betters, David R.; Markstrom, Donald C.; Aukerman, Robert. 1990. Cost, time, and benefit measures for personal use fuelwood collection in Colorado. Res. Pap. RM-287. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

The average fuelwood collector is willing to pay, beyond current perceived costs, an additional $21 to $29 per cord in order to continue collecting fuelwood. The difference between willingness-to-pay estimates for fuelwood collection and for wood purchased from a commercial vendor is assumed to represent recreational value of fuelwood collection. On this basis, the recreation values for the average collection is estimated to be between $6 and $12 per cord.

Keywords: Fuelwood, firewood, valuation, cost, nonmarket good, willingness to pay

Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526